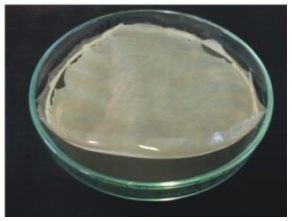
University of Palermo
Department of Physics and Chemistry

CHIMICA DEI MATERIALI

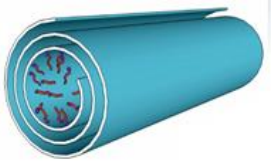
Giuseppe Lazzara, Stefana Milioto

Our recent research activities

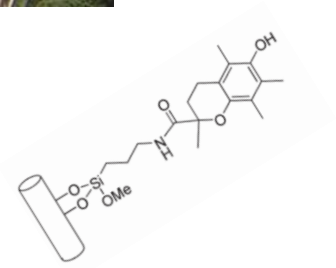
- Bio-nanocomposites based on halloysite



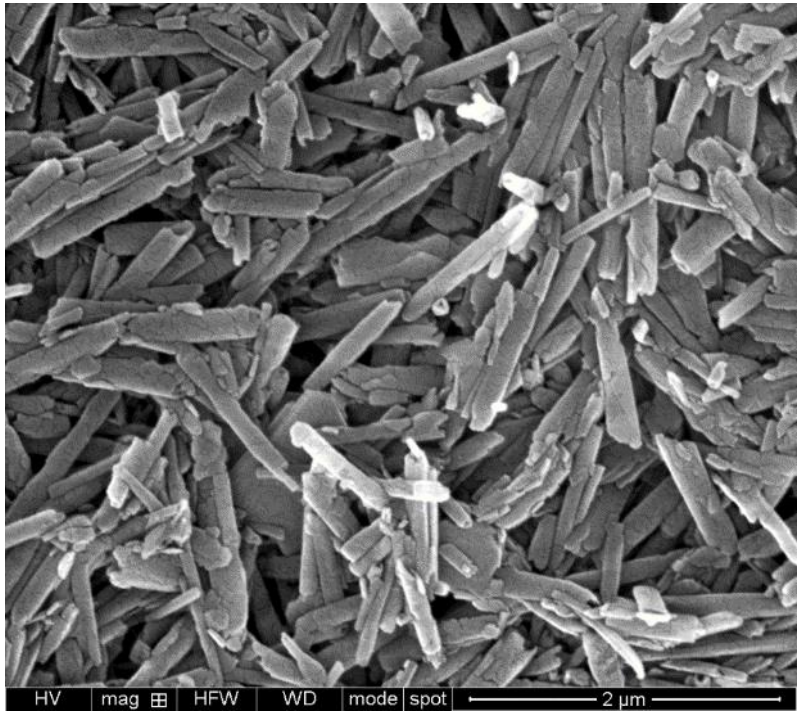
- Halloysite-surfactant hybrid materials

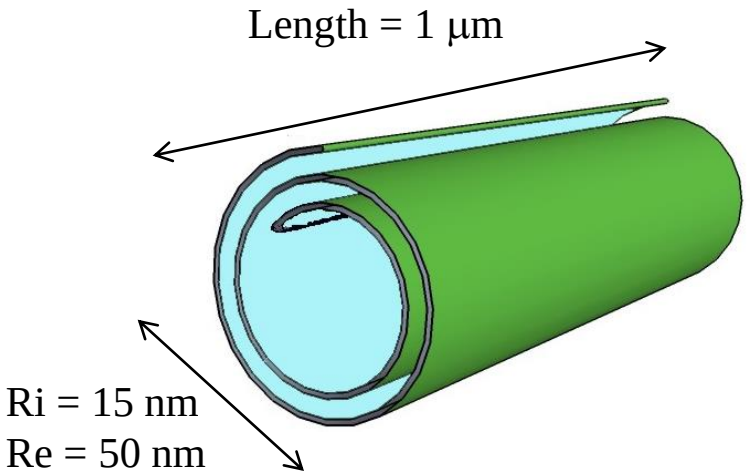


- Chemical modification of Halloysite



Halloysite nanotubes





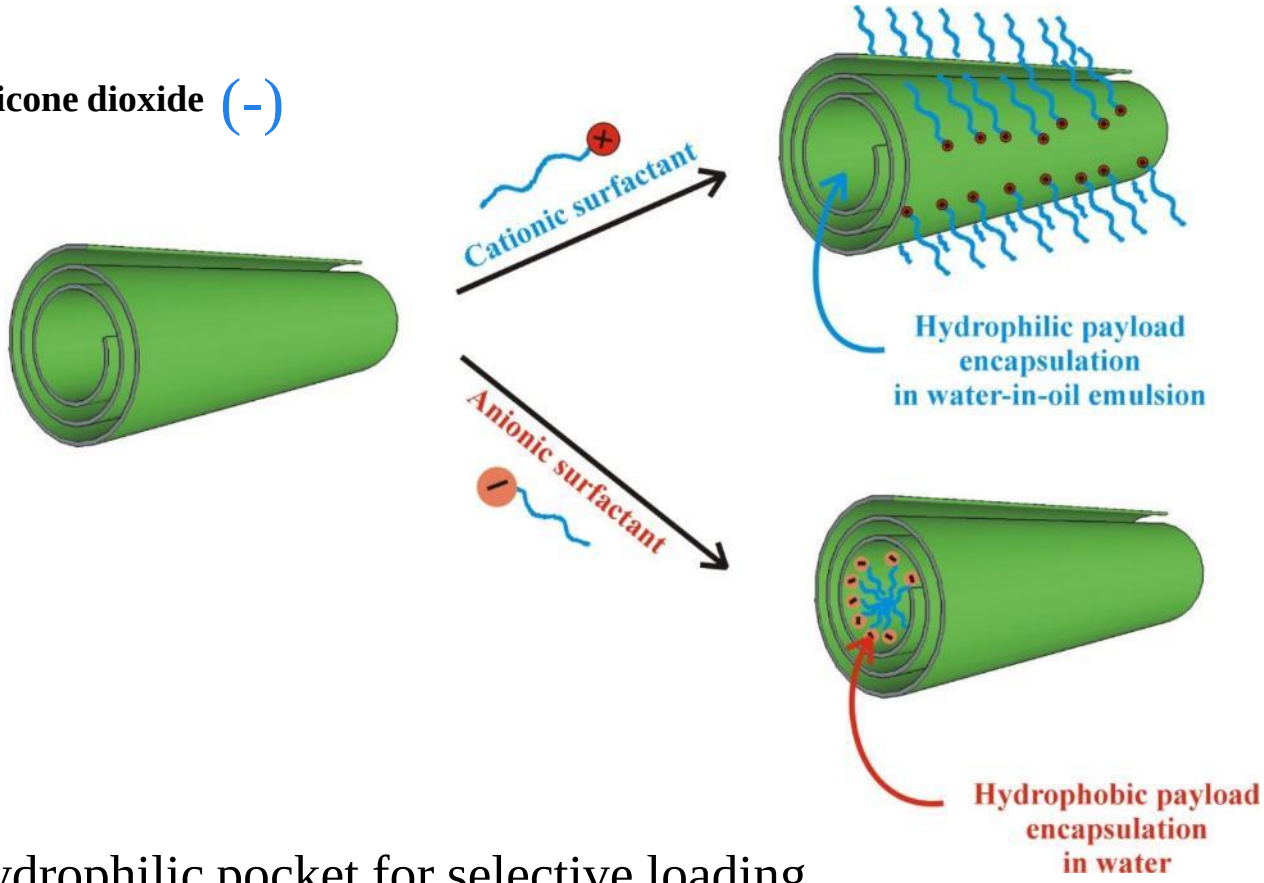
$Al_2Si_2O_5(OH)_4 \cdot 2H_2O$

- **Different surface chemistry**
- **Available cavity**

Selective adsorption of surfactants

Inner surface: aluminum oxide (+)

Outer surface: silicone dioxide (-)



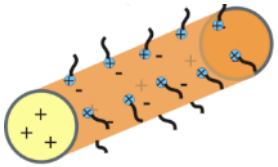
Hydrophobic/hydrophilic pocket for selective loading

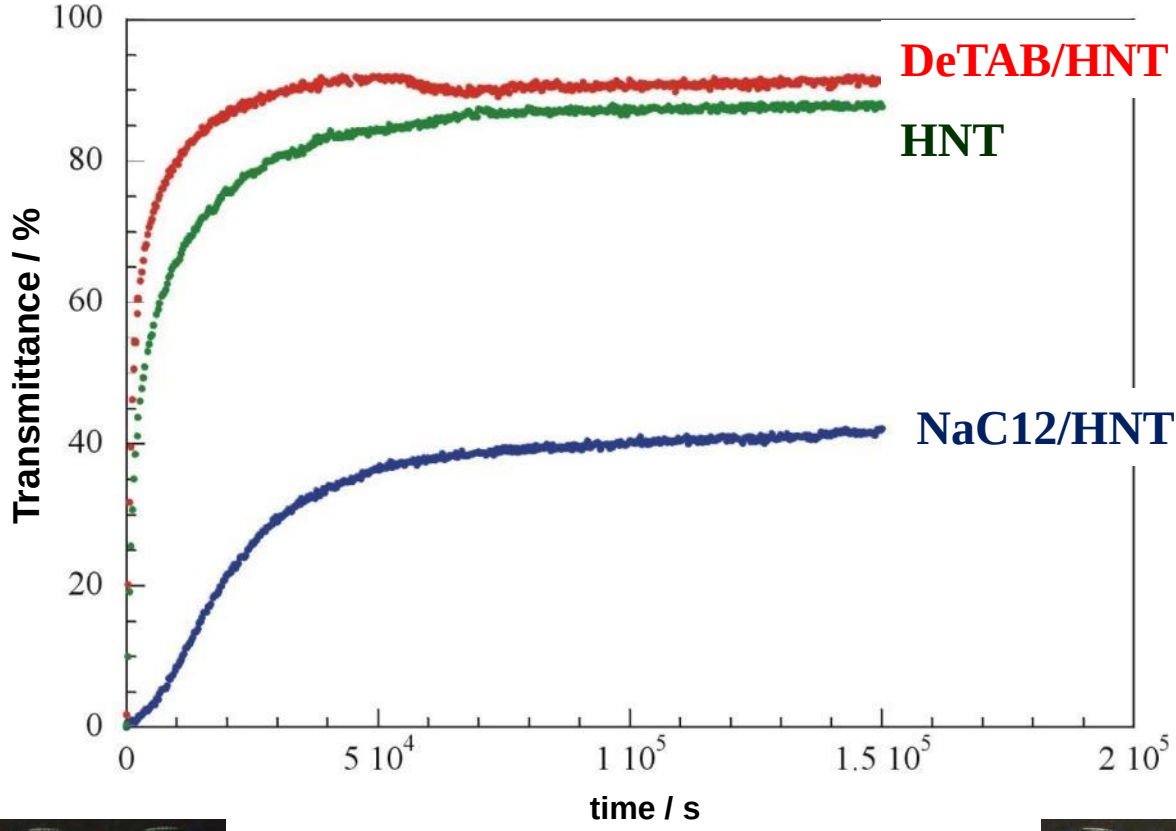
Cavallaro, G.; Lazzara, G.; Milioto, S. *J. Phys. Chem. C* **2012**, *116*, 21932

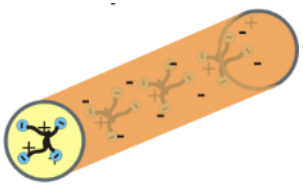
Cavallaro, G.; Lazzara, G.; Milioto, S.; Parisi, F.; Sanzillo, V. *ACS Appl. Mater. Interfaces* **2014**, *6* , 606

Cavallaro, G.; Lazzara, G.; Milioto, S.; Parisi, F. *Langmuir* **2015**, *31*, 7472–7478

Colloidal stability







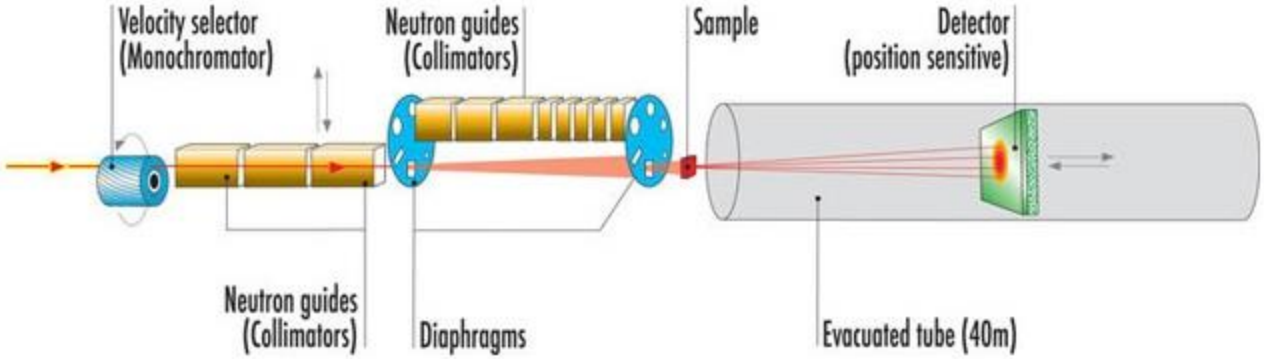
after 40 hours

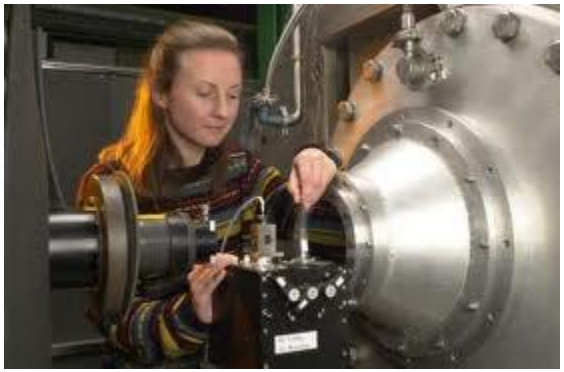
DeTAB/HNT HNT NaC12/HNT

DeTAB/HNT HNT NaC12/HNT

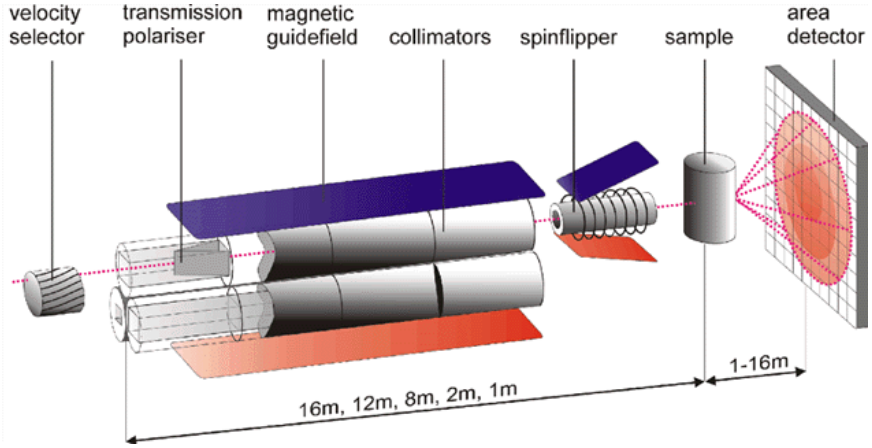
The structure of the hybrid material

Small Angle Neutron Scattering





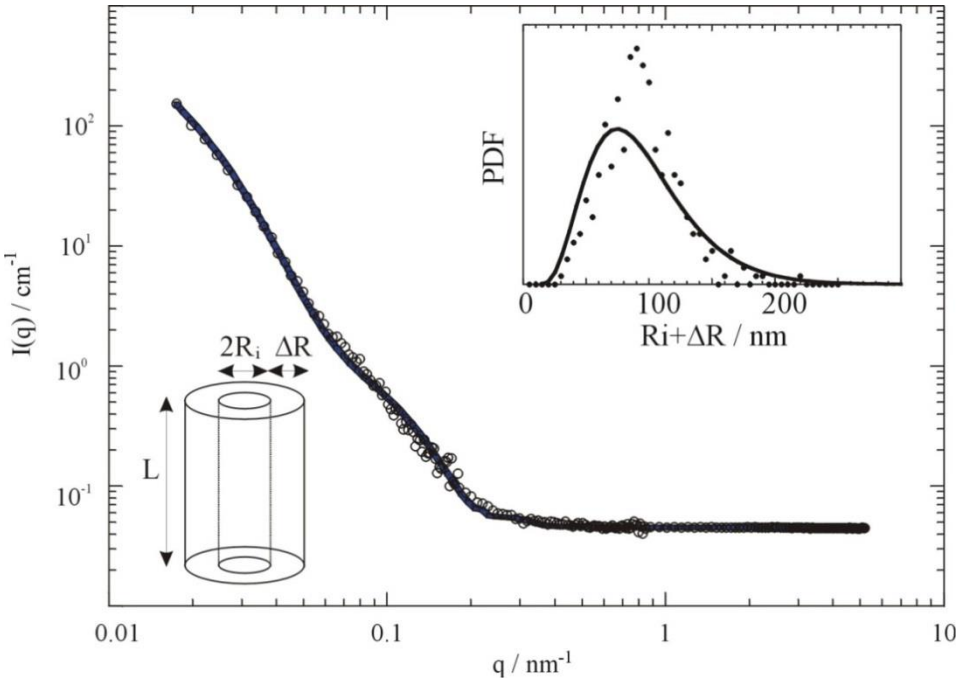
ILL Neutron facility in Grenoble (France)

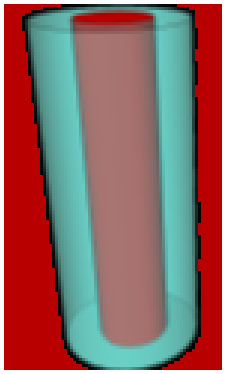


BENSC facility in Berlin (Germany)

Small Angle Neutron Scattering (SANS)

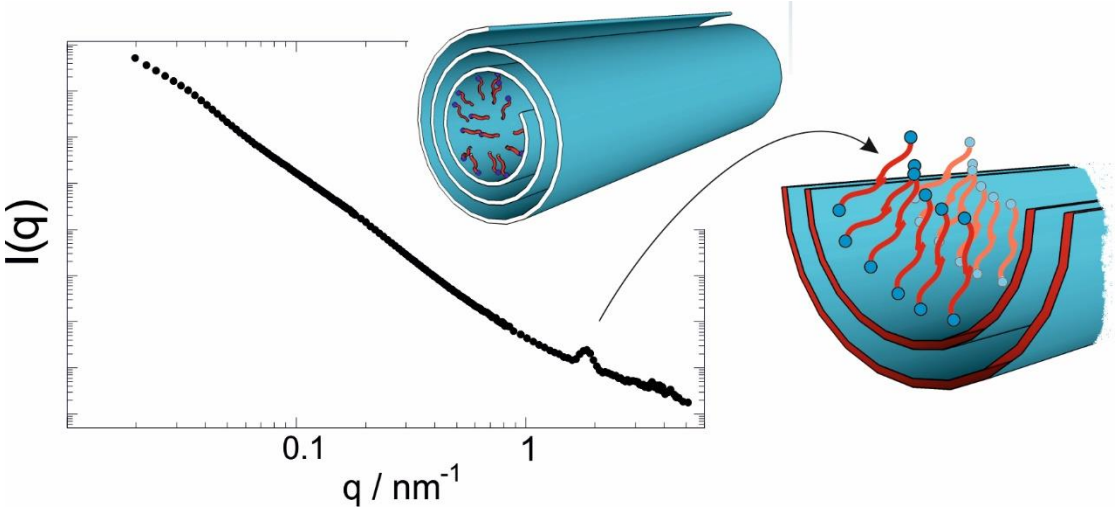
HNT/D_2O

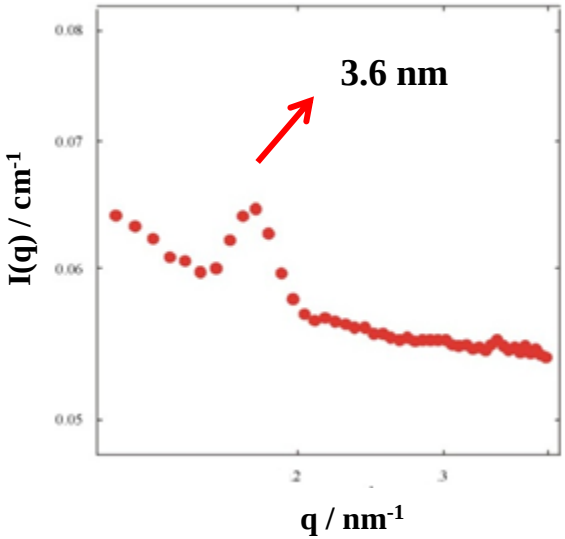




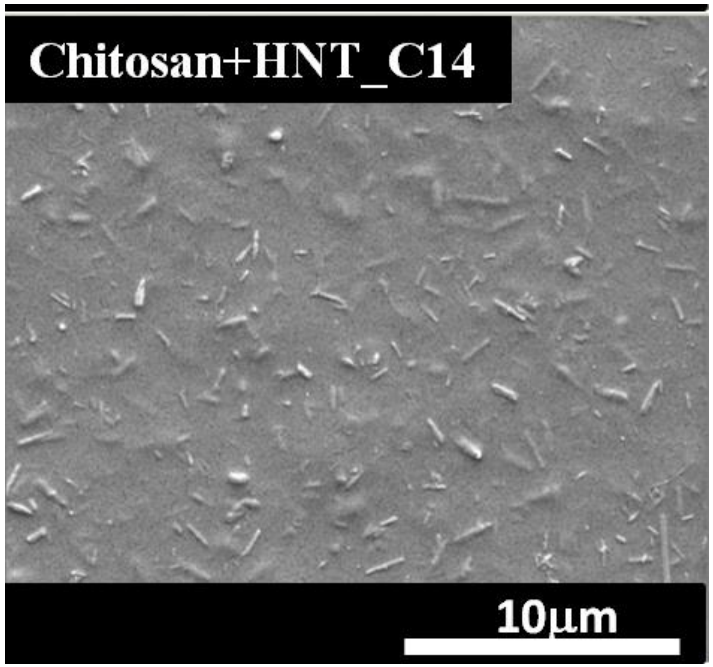
Hollow cylinder

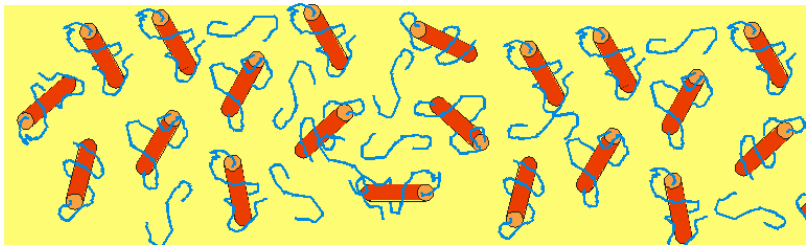
Ri = 15 nm
Re = 70 nm
Lenght = 500 nm





Eco-friendly sponge for organic solvents

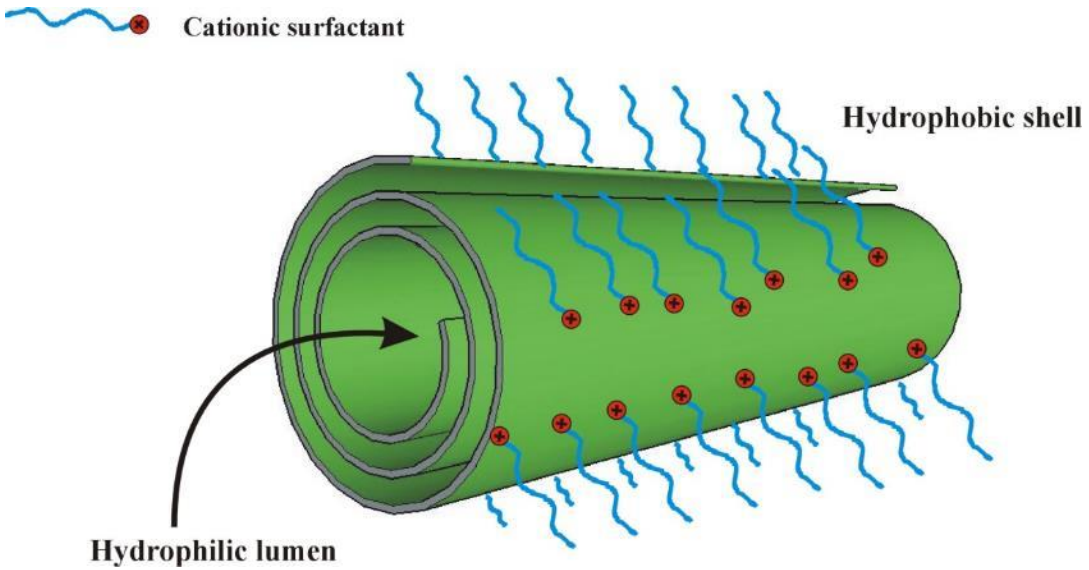




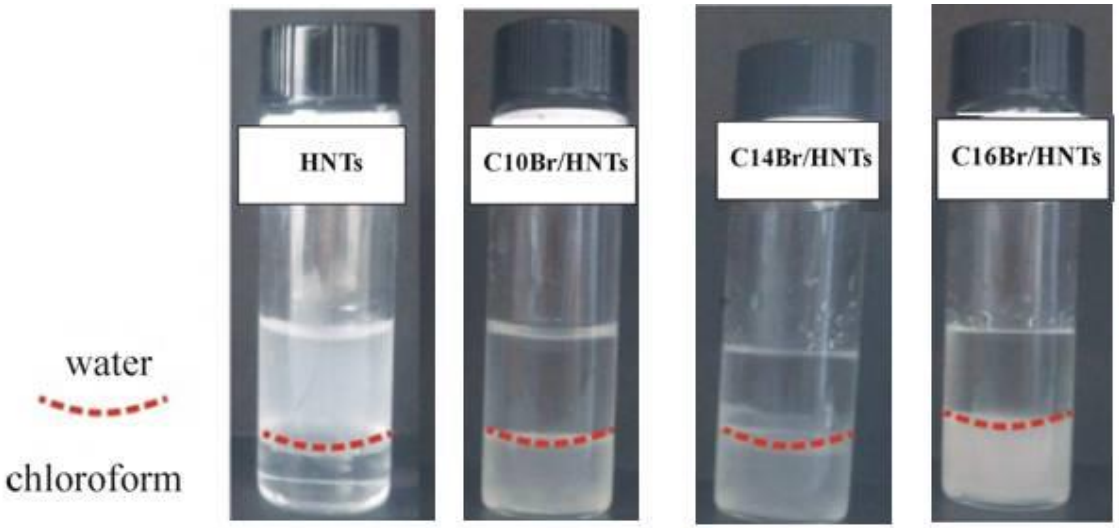
Good nanoclay dispersion in the polymer matrix

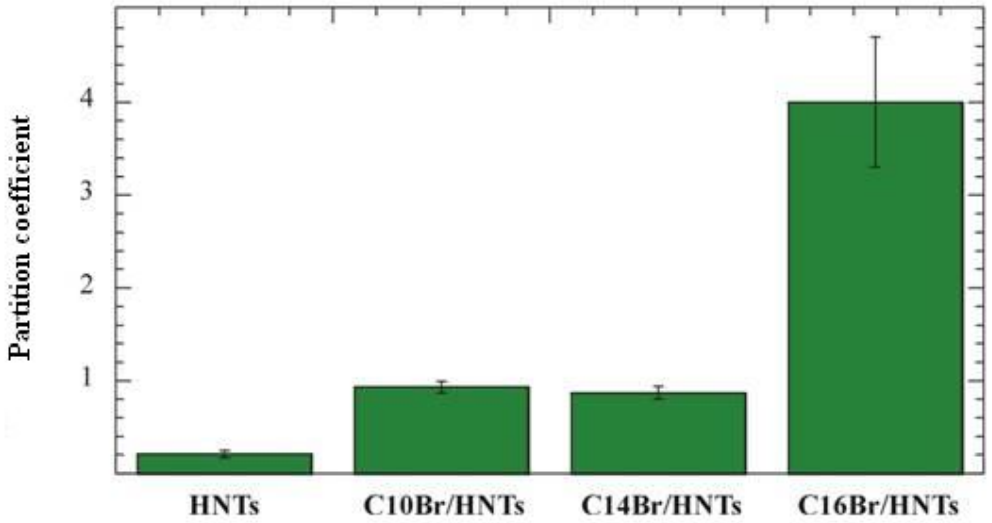
Cavallaro, G.; Lazzara, G.; Konnova, S.; Fakhrullin, R.; Lvov, Y. *Green Materials* **2014**, *2*, 232–242.

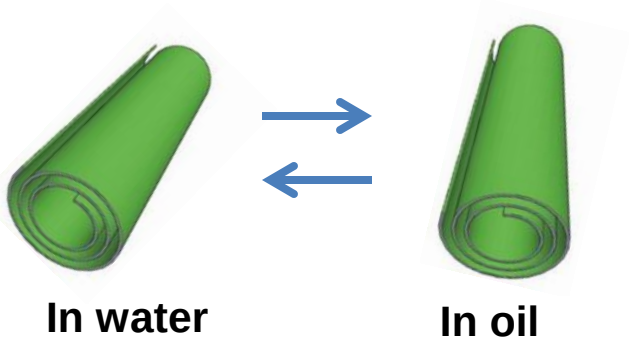
Reverse inorganic micelles



Partition between water and oil







Cavallaro, G.; Lazzara, G.; Milioto, S.; Parisi, F. *Langmuir* **2015**, *31*, 7472–7478

Applications for Cultural Heritage

Cleaning

Consolidation:

Paper

Cavallaro, G; Lazzara,G; Milioto, S; Parisi, F.
Halloysite nanotubes with fluorinated cavity: an innovative consolidant for paper treatment
Journal of Clay Minerals **2016**, *just accepted*

Wood

Cavallaro G, Lazzara G, Milioto S, Parisi F, Sparacino V.
Thermal and dynamic mechanical properties of beeswax-halloysite nanocomposites for consolidating waterlogged archaeological woods.
Polymer Degradation and Stability. 2015;120:220–5.

Waterlogged Archaeological Woods

17th century ship – Vasa Museum, Stockholm

General conservation state:

- highly degraded
- high porosity (even more than 90% !)
- low mechanical resistance

drying

Consolidation is a key issue!

Macroscopic observation of beeswax/HNT nanocomposites

Beeswax

Beeswax + HNT 60 %

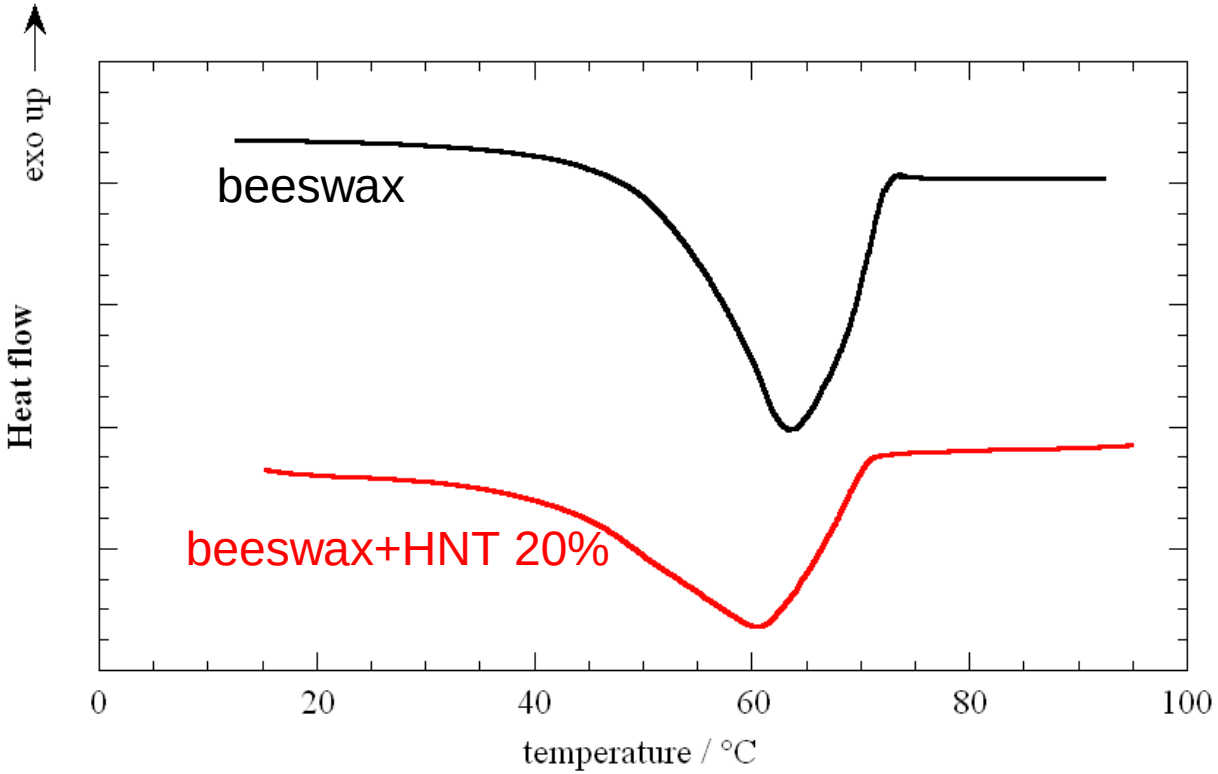
T : 75 °C
t : 0 s

T : 75 °C
t : 7 min

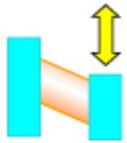
Cavallaro, G.; Lazzara, G.; Milioto, S.; Parisi, F.; Sparacino, V. Polym.Degrad. Stab. 2015, 120, 220–225.

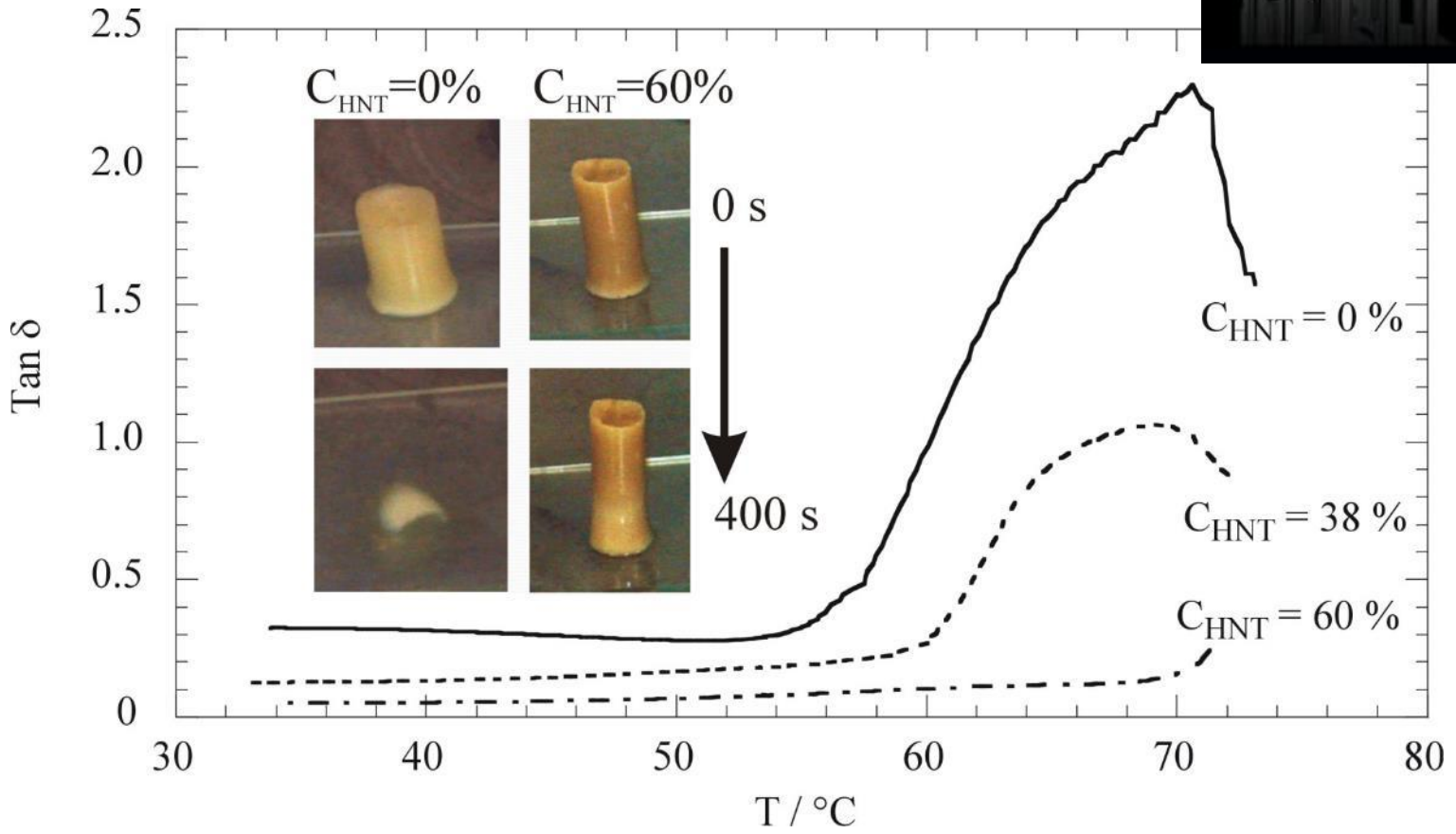
Zhao, Y.; Thapa, S.; Weiss, L.; Lvov, Y. Advanced Engineering Materials 2014, 16, 1391–1399.

DSC characterization of beeswax/HNT nanocomposites

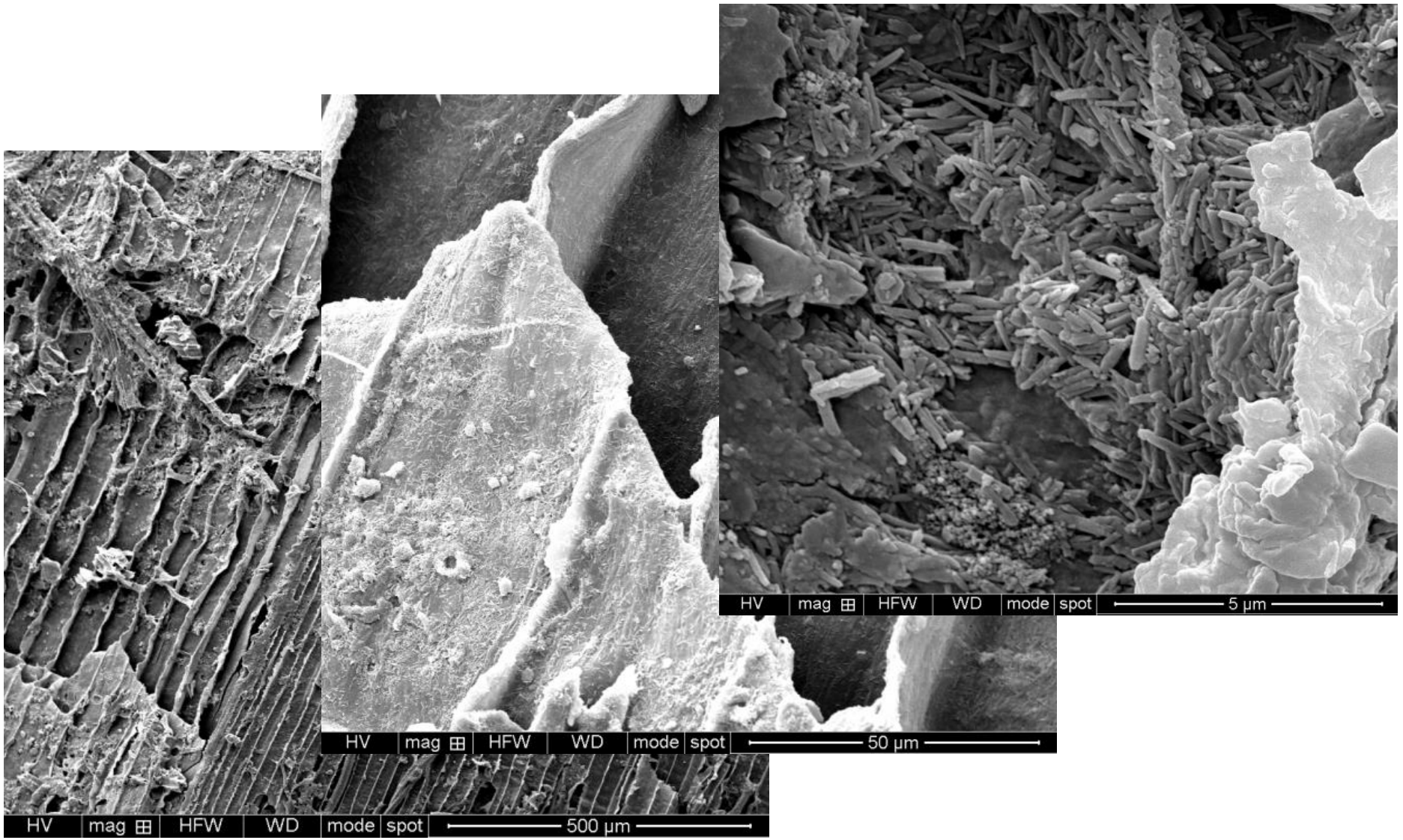


Tanδ data for beeswax/HNT





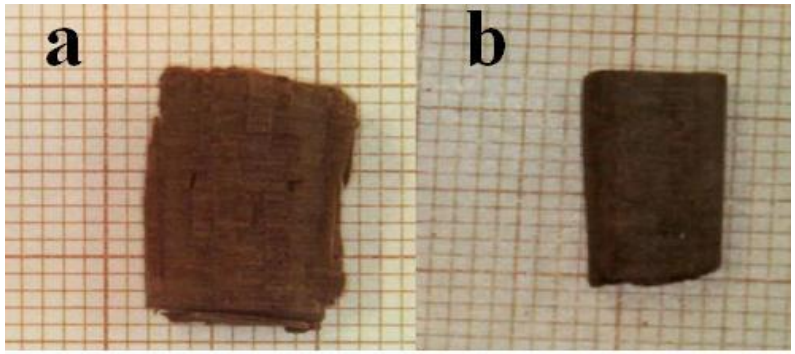
SEM images from waterlogged wood treated with beeswax/HNT



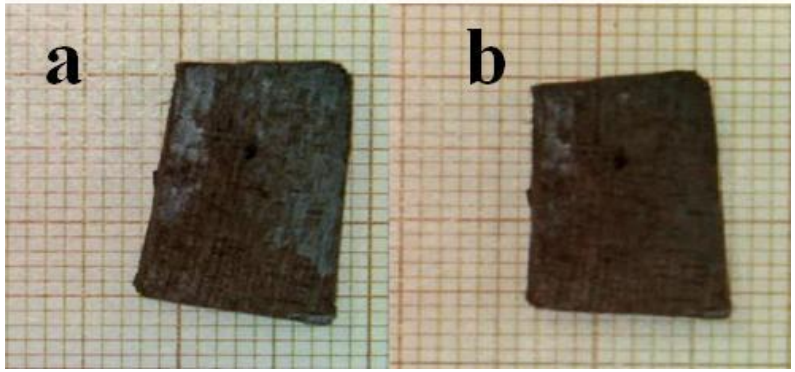
Waterlogged Archaeological Woods shrinking effect

Before drying

After drying



Untreated sample



Sample treated with beeswax/HNT

HNT% in the dried consolidant	ΔV (%)
Untreated wood	40,6
0	11,61
30	6,2

Cavallaro, G.; Lazzara, G.; Milioto, S.; Parisi, F.; Sparacino, V. *Polym.Degrad. Stab.* 2015, 120, 220–225.

Metodi

Analisi termica: TGA, DMA, DSC, micro-DSC

Termodinamica in soluzione: nano-ITC, velocità del suono, densità, osmometria

Large facilities: SANS

Superficie: angolo di contatto, tensione superficiale

Collaborations

TU-Berlin
- Prof. M. Gradzielski

ILL-Grenoble
- Dr. I. Grillo

Kazan Federal University
- Prof. R. F. Fakhrullin

La-Tech
- Prof. Y. Lvov

Monash University
- Dr. P. Pasbakhsh